5-12-2015

محاضرة [8] ميكانيكا موائع.

chapter (4)

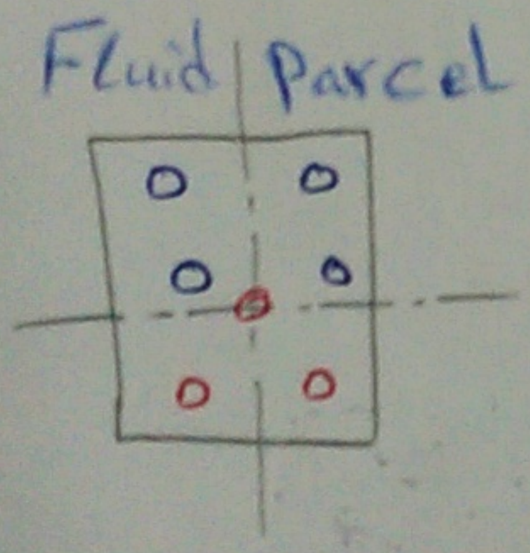
* Fluid Kinematics.
* Description of Flow Fields (ReFence Frames).
* Acceleration Field (Material Dev.)
* Flow visualization concepts.
* Flow visualization Techiques (Report).

[1] lagrangian Description of flow Field.

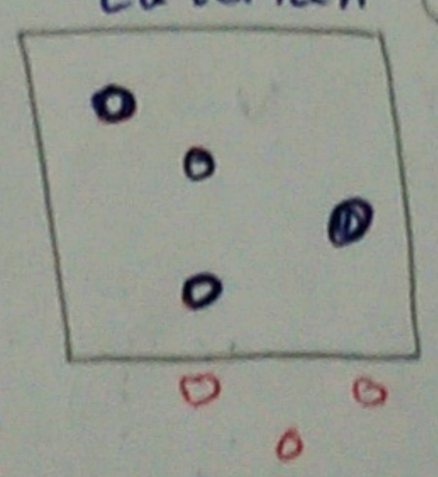
[system consideration]

[2] Euleran Descryption.

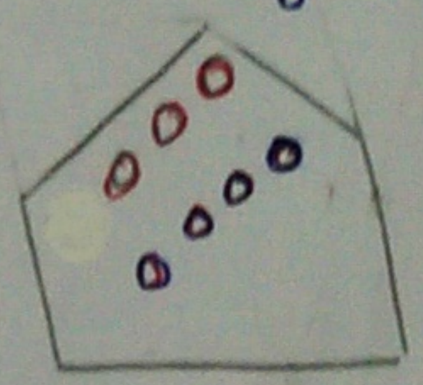
[c.v. consideration]



at time (t)



(الإحداثيات ثابتة)



at time (t-dt)

(الإحداثيات متحركة مع المائع.)

بحيث يكون جزيئات المائع داخل الإحداثيات دائما.

[b]

Material Dervative (acceleration Field).

Eulerian & lagraian حلقة وصل بين

$$\vec{a} = \frac{d\vec{v}}{dt} \qquad \text{but} \rightarrow \vec{v} = u\hat{i} + v\hat{j} + w\hat{k}$$

$$\vec{v} = \frac{\partial x}{\partial t}\hat{i} + \frac{\partial y}{\partial t}\hat{j} + \frac{\partial z}{\partial t}\hat{k}$$

$$\vec{a} = \frac{d}{dt}(ui + vj + wk)$$

$$\vec{a} = \frac{du}{dt}\hat{i} + \frac{dv}{dt}\hat{j} + \frac{dw}{dt}\hat{k}$$

$$\frac{du(x,y,z,t)}{dt} = \frac{\partial u}{\partial t} + \frac{\partial u}{\partial x}\cdot\underbrace{\frac{dx}{dt}}_{u} + \frac{\partial u}{\partial y}\cdot\underbrace{\frac{dy}{dt}}_{v} + \frac{\partial u}{\partial z}\cdot\underbrace{\frac{dz}{dt}}_{w}$$

$$= \frac{\partial u}{\partial t} + u\frac{\partial u}{\partial x} + v\frac{\partial u}{\partial y} + w\frac{\partial u}{\partial z}$$

$$\nabla = \frac{\partial}{\partial x}\hat{i} + \frac{\partial}{\partial y}\hat{j} + \frac{\partial}{\partial z}\hat{k}$$

deloperator (gradient)

$$\frac{dv}{dt} = \frac{\partial v}{\partial t} + u\frac{\partial v}{\partial x} + v\frac{\partial u}{\partial y} + \frac{w\,\partial u}{\partial z}$$

$$\boxed{\frac{dw}{dt} = \frac{\partial w}{\partial t} + u\frac{\partial w}{\partial t} + v\frac{\partial w}{\partial y} + w\frac{\partial w}{\partial z}}$$

$$\vec{a} = \frac{d\vec{v}}{dt} = \frac{\partial \vec{v}}{\partial t} + u\frac{\partial \vec{v}}{\partial x} + v\frac{\partial \vec{v}}{\partial y} + w\frac{\partial \vec{v}}{\partial z}$$

$$\therefore \quad \vec{a} = \underbrace{\frac{\partial \vec{v}}{\partial t}}_{\text{Local}} + \underbrace{\vec{v}\cdot\nabla\vec{v}}_{\text{Convective Term}} = \frac{D\vec{v}}{Dt}$$

Local: تغير الخاصية بالنسبة لزمن

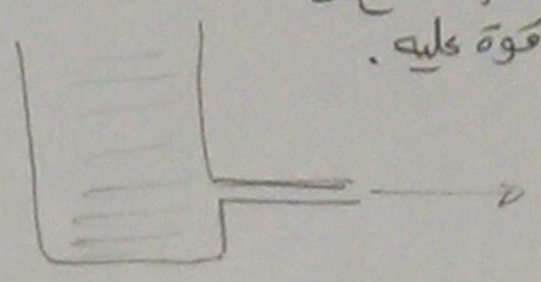
Convective Term: تغير الخاصية بالنسبة للمكان

(x, y, z, t)

$$\frac{D\rho}{Dt} = \frac{\partial \rho}{\partial t} + \vec{V} \cdot \nabla \rho$$

$$= \frac{\partial \rho}{\partial t} + u\frac{\partial \rho}{\partial x} + v\frac{\partial \rho}{\partial y} + w\frac{\partial \rho}{\partial z}$$

مثال خزان فيه مائع يخرج المائع من أسفل دون بذل أي قوة عليه.



$\frac{\partial (\ )}{\partial (x,y,z)} = 0$ → steady flow

مثال مهم / امتحانات

$$\vec{V} = 3t\,\hat{i} + xz\,\hat{j} + ty^2\,\hat{k}$$

Find accelration of particle at location (3, 2, 3) at $t = 5$ sec.

$u = 3t$ $\quad \frac{\partial u}{\partial t} = 3$

$v = xz$ $\quad \frac{\partial v}{\partial t} = 0$

$w = ty^2$ $\quad \frac{\partial v}{\partial t} = y^2$

$$\frac{\partial \vec{V}}{\partial t} = 3\hat{i} + y^2\hat{k}$$

$$\frac{\partial \vec{V}}{\partial x} = z\hat{j}$$

$$\frac{\partial \vec{V}}{\partial y} = zt\hat{k}$$

$$\frac{\partial \vec{V}}{\partial z} = x\hat{j}$$

$$\vec{a} = (3\hat{i} + y^2\hat{k}) + [3tz\,\hat{j}] + [2xzt\hat{k}] + [xty^2\hat{j}]$$

($3tz\,\hat{j}$: u)

$$= [3\hat{i}] + [3tz + xty^2]\hat{j} + [y^2 + 2xzt]\hat{k}$$

($3tz$: $3 \uparrow 5 \uparrow 3$; xty^2: $3 \uparrow 2$)